DOE'S BUSINESS LINES

ENERGY RESOURCES BUSINESS LINE

Energy is the vital force powering business, manufacturing, and movement of goods and services throughout the country. The United States spends over one-half trillion dollars annually for energy, and our economic well-being depends on reliable, affordable supplies of clean energy. Energy is also a global commodity. With growing worldwide populations, rising living standards, and economies in transition to market-based systems, the demand for energy is increasing in an ever more globalized energy market. These factors could contribute to several trends that would negatively impact our economy, environment, and energy security during the first half of the 21st century. To counteract these trends, it may be necessary to significantly change the way we supply and use energy.

In order to meet the Nation's energy needs in the 21st century, DOE is committed to the following policy principles:

- Reliance on competitive market as the "first principle" of energy policy;
- Support for energy science and technology development;
- Promotion of government/industry/ consumer partnerships;
- Use of targeted incentives and regulations; and
- Facilitation of international cooperation.

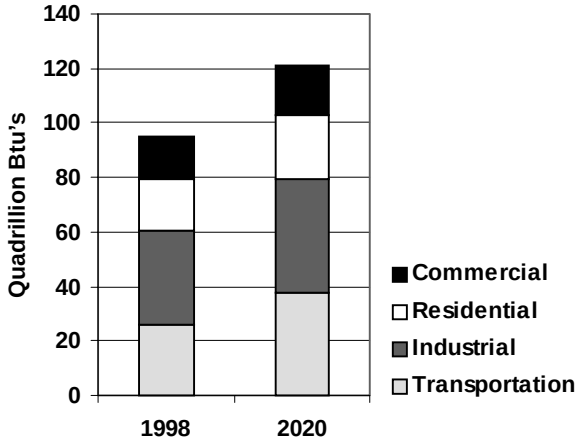
As an agent to affect both policy and technology development, DOE has unique roles and responsibilities.

The Department's goal in Energy Resources is to promote the development and deployment of energy systems and practices that will provide current and future generations with energy that is clean, efficient, reasonably-priced, and reliable. The Department pursues this goal through a variety of approaches, including market reforms that increase competition while assuring reliability, the development of improved energy technologies and standards, energy-related information, voluntary programs, and the maintenance of emergency oil reserves.

Situation Analysis

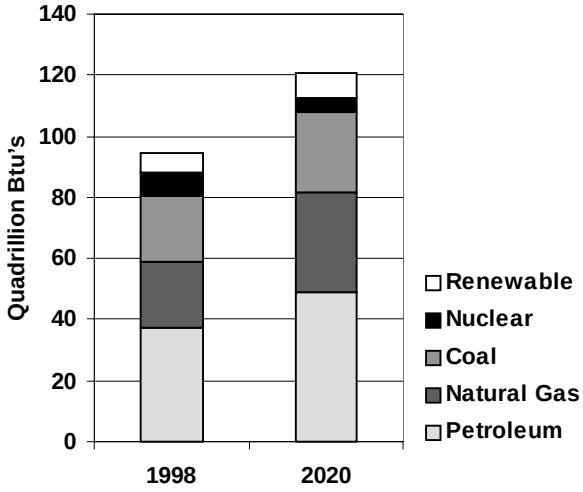
U.S. Energy Supply and Consumption. The two charts below show energy supply by type of fuel, and the amount of energy that is consumed in each sector of the economy.

Energy Consumption by Sectors



Source: *Annual Energy Outlook 2000*

Energy Supply by Fuel Type



Source: *Annual Energy Outlook 2000*

In 1998, the total U.S. energy consumption was about 95 quadrillion BTU's, which was about 25 percent of the world total, and that figure is projected to increase to about 120 quadrillion BTU's by 2020. As can be noted from the 1998 data, the energy supply is dominated by fossil fuels (coal, oil, and natural gas), which account for 85 percent of the total. America's energy resources are extensive and diverse. Coal, oil, natural gas, and uranium are abundant, and a variety of renewable resources are available in large untapped quantities. The United States produces almost twice as much energy as any other nation, nearly as much as Russia and China combined. Our Nation uses most of this energy domestically, although it exports considerable amounts of coal, refined petroleum products, and enriched uranium. It is significant that the United States relies on petroleum for about 40 percent of its energy supply, and over 50 percent of this petroleum is imported.

The second graph illustrates how energy is consumed among the four basic demand sectors of our economy: transportation, industrial, residential, and commercial. In the transportation sector, petroleum currently accounts for nearly 97 percent of fuels consumed. A wide variety of fuels are used in the industrial sector, while energy use in the residential and commercial sectors is dominated by natural gas and electricity. Over 35 percent of energy consumed in the United States is used to generate electricity. However, nearly 70 percent of that energy is lost, mainly as waste heat in the generation process.

Energy Trends and Challenges. The supply and demand projections for 2020 are based on expected energy trends, which, in turn, depend on future energy policies and the development and deployment of new energy-supply and energy-efficiency technologies. Technology advances resulting from both Federal and private sector R&D investments are having a positive impact. Nevertheless, the overall domestic demand for

energy is expected to grow, which is likely to increase U.S. reliance on oil imports.

Technology advances are reducing the cost of energy production and electricity, enhancing the ease and affordability of transportation, and improving the comfort and utility of residential and commercial buildings. Advances are also supporting a vibrant and competitive industry. Technology advances have been key drivers in the decrease in energy intensity that the United States has achieved post-1970s.

The U.S. economy is demanding less energy per unit of goods produced. The rate of economic growth, as measured by the Gross Domestic Product (GDP), has outpaced the rate of primary energy consumption and it is projected to continue to do so. Hence, energy intensity—the ratio of energy consumption to GDP—is forecasted to continue to decrease.

Advanced energy technologies are also helping to limit or reduce environmental damage. For example, technology has enabled, at modest cost, significant reductions in the emission of most conventional air pollutants produced from the combustion of fossil fuels.

Various government agencies are working together to remove unnecessary government regulation and to institute regulatory reforms to revitalize our competitive market forces. The result has been to increase the economic efficiency of the U.S. energy system, which has in turn helped reduce energy prices from the highs experienced in the early 1980s.

In spite of the improvements brought about by better technology and regulatory reforms, total energy use has continued to increase in the 1990s. Important contributing factors include the growing U.S. population, increased production and use of light trucks (minivans and sport utility vehicles), and greater use of electrical equipment in our homes and businesses (for example, air conditioners, computers, and motors). Assuming energy and electricity prices remain near the year 2000 levels, energy consumption is likely to continue to increase.

Increasing energy demand by the transportation sector is likely to expand U.S. reliance on oil and oil imports. Improved technology has enabled the United States to boost energy production in many areas; however, these advances have been insufficient to counter the gradual decline of U.S. oil reserves and production. Based on this trend, EIA has projected oil imports to increase from 51 percent in 1999 to 64 percent in 2020.

In addition to greater reliance on oil imports, the Nation will be challenged by a rapidly increasing demand for electricity that could strain the ability of the U.S. electric system to provide reliable and affordable service, especially during periods of peak demand. Furthermore, the anticipated increased demand for fossil fuels is likely to increase emissions of greenhouse gases, which will make further reductions in the emissions of conventional air pollutants more difficult. Fossil fuels account for about 98 percent of man-made, carbon greenhouse gas emissions in the United States.

These trends and new challenges were captured in the final report of the Energy Research and Development Panel of the President's Committee of Advisors on Science and Technology (PCAST), November 1997, that stated:

> *"The United States faces major energy-related challenges as it enters the twenty-first century. Our economic well-being depends on reliable, affordable supplies of energy. Our environmental well-being— from improving urban air quality to abating the risk of global warming—requires a mix of energy sources that emits less*

carbon dioxide and other pollutants than today's mix does. Our national security requires secure supplies of oil or alternatives to it, as well as prevention of nuclear proliferation. And for reasons of economy, environment, security, and stature as a world power alike, the United States must maintain its leadership in the science and technology of energy supply and use."

Government Role. During the late 1970s, it became apparent that the decades-old regulation of energy prices was counterproductive and that the Nation should pursue market-oriented approaches to energy supply and use wherever possible. A consensus developed that competitive markets should be the cornerstone of a successful energy policy, but also that society cannot rely on markets alone to achieve all of society's economic, environmental, and security goals. A role remains for the government because market forces are generally not able to capture or reflect benefits that accrue to the society at large.

The role of government in energy is now focused on the important tasks of improving the operation of competitive markets and addressing the market's inherent limits. This approach allows markets to be the key determinants of supply and demand, while government supplements market forces through policies that bolster energy security and provide for a cleaner environment.

In this context, the Federal government focuses on augmenting energy security by maintaining the Strategic Petroleum Reserve and coordinating emergency responses with our allies in the International Energy Agency. To reduce dependence on oil imports, the government also promotes increased domestic oil and gas production and encourages reduced oil consumption through efficiency and the use of alternative fuels. Furthermore, the Federal government promotes measures to protect the domestic energy infrastructure and maintain military preparedness. The Federal government also seeks to encourage favorable conditions in energy-producing regions of the world to facilitate access of all oil and gas resources to global energy markets.

The government reduces negative environmental effects by developing cleaner and more efficient energy technologies, regulating pollution, and setting standards for energy use in consultation with the private sector. In addition, it ensures that any access to environmentally sensitive public lands is conducted with minimal impact. The government ensures the flow of new and cleaner energy technologies by funding energy research, development, and demonstration, in concert with the private sector. Ultimately, the continued development of new technologies improves the efficiency of end use and reduces the negative environmental effects of energy production and use and thus contributes to a high quality of life.

The Federal government's energy role is articulated through the goals, objectives, and strategies in the April, 1998, *Comprehensive National Energy Strategy* (CNES), developed by DOE and other Federal agencies with input from many stakeholders. The CNES identifies actions that help to increase energy supply diversity and fuel choices, bring renewable energy sources into the market, strengthen domestic production of oil and gas, support commercial nuclear energy research, and increase the efficiency of both power production and end-use technologies. DOE is the lead Federal agency in implementing CNES through our efforts to assure clean, affordable, and dependable supplies of energy for our Nation. More recently, the

accomplishments, investments, and current challenges of the Department were summarized in *Powering the New Economy* (available at www.policy.energy.gov).

The Department's Energy Resources mission is performed through the integrated efforts of a number of DOE organizations. Three of them—the Office of Energy Efficiency and Renewable Energy, the Office of Fossil Energy, and the Office of Nuclear Energy, Science and Technology—manage the research, development, and deployment of advanced energy technologies. This work is performed primarily through partnerships with industry, Federal and non-Federal laboratories, universities, and Federal, State, and local government agencies. Another DOE organization, the Energy Information Administration, publishes energy-related information necessary for informed consumer, market, and policy decisions. The Power Marketing Administrations sell and distribute more than $3 billion of electric power generated at Federal hydroelectric plants. DOE's Office of International Affairs and Office of Policy are the lead organizations for many of the policy-related thrusts supporting the Energy Resources goal.

Key External Factors

Factors external to DOE's direct control can influence desired energy resources outcomes. They include:

- The way that environmental regulations and policies will develop over time.
  - Reducing the levels of greenhouse gas emissions may prove to be one of the most important strategic drivers of energy policy, especially if international climate change agreements are reached that require significant reductions in projected U.S. emissions.
  - Changes in Federal or State regulations governing energy-related air emissions, motor fuel quality, and other liquid/solid waste streams, will affect both the types of energy and technologies used.
  - Competing Federal, State and local environmental and land management priorities could affect the ability of the private sector to produce and deliver energy to consumers.
- Changes in the pace or direction of energy market restructuring.
  - Without a national legislative framework for moving forward with electricity market restructuring, industry investment in new technology could be adversely affected with implications for consumer prices in the future.
- Unexpected developments in international energy markets.
  - Worldwide demand for oil and other energy resources may place upward pressure on international energy prices.
  - Uncertain rates of production by major oil-producing nations could increase price volatility, which tends to make domestic oil investments and investments in alternative energy technologies more risky.

- Unexpected scientific and technological developments.
  - The implications for energy use of the new digital economy and related technological advances are not yet well understood.
- Changes in market and economic trends.
  - The rate of economic growth will have an important effect on energy demand and the level of private investment.
  - Existing trends toward lower private sector investments in R&D could affect the rate of development of energy technologies.

DOE will continue to work with its stakeholders and Congress to promote legislation, regulations, and policies that may be needed to address these and related economic, demographic, social, or environmental issues.

In the face of these uncertain factors, DOE continues to press for the development of advanced technologies that can help the Department meet its energy security, environmental, and economic goals. In fostering new technologies, DOE offices will leverage Federal funding by developing partnerships with other DOE offices, other Federal agencies, Tribal Nations, State and local governments, foreign governments, national laboratories, universities, industry, and other stakeholders to plan, fund, and implement programs.

Interagency Crosscutting Coordination

DOE's goals and objectives reflect the unique roles and responsibilities of the Department. Nonetheless, success will depend upon closely coordinated planning and continued working relationships with a number of Federal agencies, State and local governments, Tribal Nations, private industry, and Congress.

It is especially important to recognize the complementary role other Federal agencies play in our energy programs. For example, DOE's activities to reduce the cost of producing domestic oil and gas resources must be coordinated with the Department of the Interior and Department of Agriculture because these agencies manage public lands that overlie large quantities of domestic energy resources.

The Department also participates in some crosscutting government functions and initiatives that are beyond the mission of any one agency. Responsibilities and programs relating to topics such as global climate change, basic research, and science education rely upon the expertise and capabilities of numerous agencies to meet common goals of the Administration. The Office of Management and Budget (OMB) and the White House Office of Science and Technology Policy play an important leadership role in coordinating these efforts. Each participating agency is challenged to define its role and develop programs that best use that agency's unique financial, human, and technical resources in an effort to optimize overall government performance. DOE's contribution to these crosscutting programs is founded upon the distinctive technical and scientific expertise and capabilities located within its laboratory system and facilities. The Department is committed to continue working closely with other Federal

agencies and with OMB and Congress to ensure that its programs provide critical and unique contributions to these crosscutting efforts.

Congressional & Stakeholder Consultations

DOE consults with Congress and stakeholders on a continuing basis. These consultations take place both as part of the energy resources mission and as part of normal strategic and multi-year planning and budgeting processes for individual DOE program offices. Consultations involve a large number of participants, including DOE staff, DOE laboratories, and DOE management and operations contractors; key customers in the Departments of Defense, State, Commerce, Transportation, Agriculture, and Interior, the Environmental Protection Agency, Nuclear Regulatory Commission, and National Aeronautics and Space Administration; and stakeholders including State and local government agencies, Tribal Nations, industry consortia, academic institutions, the White House Office of Science and Technology Policy, OMB, and Congressional committees. As an example of the process, DOE developed a *Comprehensive National Energy Strategy* in 1998, which included public hearings around the country and the solicitation of public comments on the draft.

Program Evaluation and Analyses

DOE continually modifies its Energy Resources programs through its own strategic planning process which includes portfolio planning and analysis, technology roadmapping, and budget planning activities. In addition, numerous other planning efforts and studies in recent years have provided important additional input to DOE's Energy Resources efforts and have influenced DOE program priorities and funding requests. Examples include:

Federal Energy Research and Development for the Challenges of the Twenty-First Century, published in November 1997, is a study conducted by an Energy R&D Panel appointed by the President's Committee of Advisors on Science and Technology. The report provides a thorough review of DOE's Energy Resources R&D Portfolio. It found that, in general, the R&D activities in the current DOE program were appropriate. While the study proposed particular changes within the programs, including some specific reductions, redirections, and increases, the most important recommendation was for a substantial increase in energy technology R&D.

Powerful Partnerships – The Federal Role in International Cooperation on Energy Innovation, published in June 1999, is a report from the President's Committee of Advisors on Science and Technology. It examined ways to improve the U.S. program of international cooperation on Energy R&D to best support U.S. priorities, and addresses the key global energy environmental challenges of the 21st century. The report recommends support for a variety of initiatives using mechanisms such as regulatory assistance, training, Federally-supported R&D, and tax credits.

The *Comprehensive National Energy Strategy*, published in April 1998, fulfills a statutory requirement of the Department of Energy Organizational Act and sets forth the Nation's national energy policy. Goals, objectives, and strategies in the report form a blueprint for the specific programs, projects, initiatives, investments, and other actions that will be developed and undertaken by the Federal government. The document places significant emphasis on the need for scientific and technological advancements to successfully implement the strategy.

Technology Opportunities to Reduce U.S. Greenhouse Gas Emissions, published in 1998, was conducted by 11 DOE National Laboratories. The study identified 47 technology pathways that offer significant potential to reduce greenhouse gas emissions. The laboratories grouped the technologies according to "Energy Efficiency," "Clean Energy," and "Carbon Sequestration" and reviewed them, with particular emphasis on the time period from the date of the study until 2030 when each technology would be most likely to make contributions toward reducing U.S. greenhouse gas emissions. The study concludes that the Energy Resources R&D Portfolio generally contains the range of advanced energy technologies that represent the best opportunities for reducing greenhouse gas emissions over time. It further recommends collaborative R&D efforts in a number of areas involving partnerships among the private sector, universities, and government.

The *Energy Resources Research and Development Portfolio*, the most recent version released in February 2000, is one of five volumes published by DOE to provide in one place a clear description of the Department's entire $7 billion research portfolio. The document is intended to help (1) describe DOE's current R&D activities and showcase recent accomplishments, (2) demonstrate that the energy portfolio is appropriately balanced to meet our long-term strategic mission goals, (3) align our technology investments with broader national policy goals, and (4) plan for future investments through technology roadmapping.

In addition to major planning studies such as those cited above, DOE continually seeks advice on issues of broad national energy importance from advisory committees and through partnerships with other groups. Examples include: (1) two studies requested by the Secretary from the National Petroleum Council titled: *Meeting the Challenges of the Nation's Growing Natural Gas Use* (December 1999) and *United States Refinery Viability and the Availability of Clean Fuels* (June 2000); (2) partnerships with the North American Electric Reliability Council and the National Petroleum Council to develop strategies for ensuring critical infrastructure protection within the energy sector (pursuant to 1999 directives); (3) reviews of DOE management practices, such as a recent review of performance by the National Academy of Public Administration; and (4) third-party reviews of program performance metrics, such as those periodically conducted by Arthur D. Little and Associates.

Finally, on September 28, 2000, the Department released its newest study, *Powering the New Economy: Accomplishments, Investments, Challenges.* The report summarizes DOE's accomplishments, R&D programs, and ongoing challenges.

Resource Requirements

The Department will only achieve its goals and objectives if it has adequate financial, human, infrastructure, and technical resources. In developing this plan, the Department assumed budget appropriations consistent with the Administration and Congress's agreed upon five-year budget deficit reduction targets through FY 2002. The Energy Resources Business Line is funded at about $2 billion per year.

Federal staffing levels are based upon the Department's internal staffing targets of about 7,600 full-time equivalent Federal employees (which includes the Power Marketing Administrations).

ENERGY RESOURCES GENERAL GOAL

Promote the development and deployment of energy systems and practices that will provide current and future generations with energy that is clean, efficient, reasonably-priced, and reliable.

The Energy Resources (ER) goal covers all aspects of domestic energy from fuel supply through end use. This goal is effectively advanced through a variety of approaches, including the development of improved energy technologies and standards, energy-related information, policies, legislation, regulation, international cooperation and the maintenance of emergency oil reserves. The Energy Resources general goal is supported by five objectives.

OBJECTIVE ER1

Promote reliable, affordable, clean, and diverse domestic fuel supplies.

Introduction

To promote reliable, affordable, clean, and diverse domestic fuel supplies, the Department pursues R&D to enhance domestic oil and gas supplies and provide fuels that reduce environmental concerns. In addition, DOE maintains the Nation's Strategic Petroleum Reserve.

R&D to enhance domestic oil and gas supplies aims to improve technologies for exploration and production. These efforts include work in areas such as diagnostics, seismic imaging, effective environmental protection, and reservoir life extension. Advances in technology are needed today and the need will increase in the future. The Nation's oil and gas resources are largely in mature, already producing areas, and remaining new sources are increasingly difficult to find and to affordably bring into production.

An increasingly important thrust for R&D is to provide fuels with greatly reduced environmental consequences. For example, through an "Ultra-Clean Transportation Fuels Initiative," DOE is pursuing fuels derived from petroleum and other hydrocarbon feedstocks (such as natural gas and coal) that can be used in advanced vehicles designed to meet anticipated emission standards (see Objective ER3: Energy Efficiency/Productivity). R&D on biofuels is stressing ethanol production as a gasoline additive and replacement fuel. Hydrogen fuels are the cleanest burning fuels that we can develop. DOE places particular emphasis in two areas: finding ways to economically produce hydrogen, and addressing the lack of an infrastructure to utilize hydrogen fuels. DOE also develops technologies aimed at the storage and distribution of gaseous hydrogen. One other relatively new area of R&D is to help ensure the integrity of the domestic natural gas delivery and storage infrastructure as domestic consumption increases a projected 40 percent by 2015.

The Strategic Petroleum Reserve (SPR) is the Nation's first line of defense against an interruption in petroleum supplies. At present, the inventory includes 570 million barrels crude oil in the Gulf Coast area, and the SPR's overall capacity is 700 million barrels. The current intent is to continue adding to the SPR inventory using royalty oil (i.e., oil provided by companies as payment for producing from Federal lands) from Federal offshore tracts. In a related action, the President, on July 10, 2000, directed DOE to offer to exchange crude oil from the SPR for heating oil and to seek out companies willing to provide up to 2 million barrels of emergency heating oil stocks and the necessary storage facilities in time for the 2000-2001 winter season. In August 2000, contracts for the storage sites were put into place.

Certain renewable sources (e.g., wind and solar) and nuclear are relevant to Objective ER1 but are not discussed here as fuels. Rather, they are covered comprehensively under Objective ER2 (Energy Transformation).

The Objective's Measures and Strategies

DOE has established the following performance measures. These measures provide the basis by which the Department will know that it has achieved the objective, or is making progress toward it. These measures will be translated into annual targets for performance plans and budgets for the Department. The following strategies describe the way in which the Department will work toward achieving this objective. These activities will be translated into annual budgets and performance plans for the Department.

Strategic Oil Reserves

Measure:

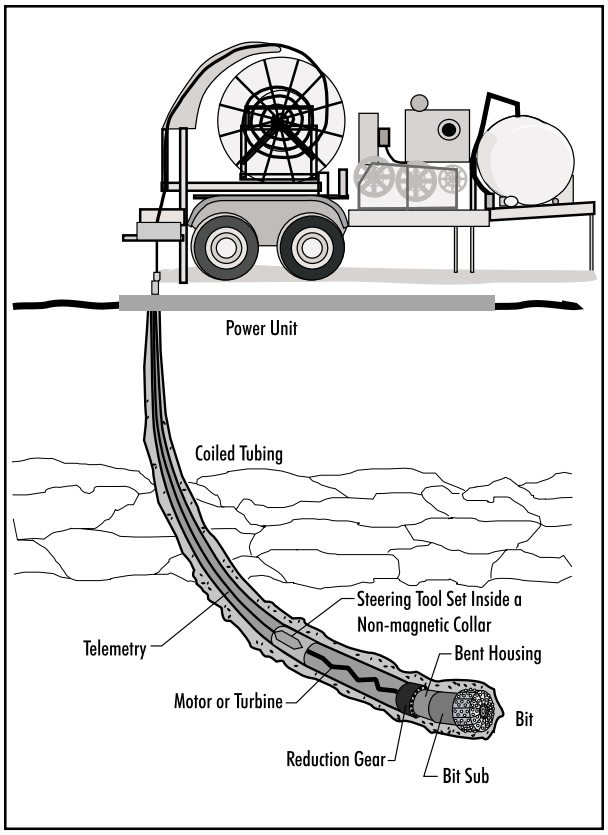
- Continue to assure the availability of the Strategic Petroleum Reserve at 95 percent or greater to enable draw down from the Reserve at a sustained rate of 4.1 million barrels per day for a sustained 90 day period within 15 days notice by the President.

- Achieve an operational Heating Oil Reserve by October 30, 2000.

Strategies:

- Maintain an effective Strategic Petroleum Reserve (SPR) to deter and respond to oil supply disruptions, and cooperate with member nations of the International Energy Agency.

- Implement the heating oil reserve through commercial exchange of SPR crude oil for two million barrels' equivalent amount of heating oil, and acquisition of interim storage tank capacity in the Northeast.



Microdrilling Technology: Drill bit attached to thin steel coil could be a major advancement in oil and gas exploration, reducing costs and environmental impacts.

Enhanced Domestic Oil and Gas Supplies

Measures:

- By 2005, increase domestic production by 600,000 barrels per day of oil and over 1.5 trillion cubic feet of natural gas per year relative to EIA's 1999 price and production forecast through development of advanced diagnostics and imaging systems, drilling technologies, more efficient recovery processes, and less expensive technology/ approaches for addressing environmental concerns.

- By 2007, provide the Nation with real-time tools and technologies that are capable of continually monitoring pipeline integrity for mechanical damage, seismic activity, and internal pipeline corrosion.

Strategies:

- Provide policy, legislative, regulatory, and technology options, as well as improved practices to enhance the availability of domestic oil and natural gas supplies, while minimizing the environmental impacts of production.

- Develop technologies and improved practices to enhance the reliability and adequacy of the domestic natural gas pipeline and storage system.

Clean Fuels

Measures:

- By 2002, achieve commercial ethanol production using non-corn biomass residues, and by 2010, incorporate into existing corn ethanol plants cellulosic ethanol production using dedicated biomass feedstocks.

- By 2005, demonstrate production of cost-competitive, ultra-clean, transportation fuels from natural gas and petroleum feedstocks with sulfur levels below the proposed EPA standard of 30 ppm average (current levels of gasoline and diesel are in the range of 300 to 500 ppm). By 2010, demonstrate the technology needed to produce fuels from these and additional carbon feedstocks (biomass, coke, coal, etc.) that can meet the much tighter Tier II Standards (cap of 15 ppm sulfur for both diesel and gasoline fuels) that are expected to be fully implemented by that time.

Biofuels: Harvesting short-rotation hybrid poplars for fiber and fuel.

- By 2004, develop and deploy hydrogen systems that are cost-effective to use with fuel cells in some applications for the production of electricity, and for transportation applications beginning in 2008.

- By 2005, increase the number of dedicated alternative fuel vehicles, the use of alternative fuel in dual-fuel capable vehicles, and the use of non-petroleum components in gasoline, displacing at least 130,000 barrels per day of petroleum-based fuels.

Strategies:

- Develop technologies to produce ultra-clean fuels from natural gas, oil, coal, biomass, and hydrogen from a variety of sources, which can be used with minimal negative environmental consequences.

- Promote the use of alternative fuel vehicles in selected niche markets (e.g., school buses, shuttles, fleets). Work with fuel providers and individual communities to help promote the development of refueling infrastructure and provide incentives for the use of alternative fuel. Promote the use of replacement fuels, such as ethanol, as blends in gasoline.

OBJECTIVE ER2

Promote reliable, affordable, and clean transformation of fuel supplies into electricity and related products.

Introduction

DOE conducts both policy and technology development activities directed toward achieving reliable, affordable, and clean methods for the transformation of fuel supplies into electricity and related products. Of interest are both centralized (i.e., large) and decentralized (i.e., distributed) systems to convert energy from its source form into one that is more useful to end users. This includes conversion of fuels to electricity and to additional co-products such as heat, mechanical energy, specialty fuels, and/or chemicals. DOE supports a variety of options to provide for competition among electricity generators and to assure open access to the transmission systems. Various technology options under development utilize fossil fuels, renewable energy resources, or nuclear power in high-efficiency, centralized energy systems and in distributed and hybrid energy systems to deliver affordable, reliable, and clean electric power. Hybrid means joining different energy technologies such as a fuel cell and gas turbine into a single system.

For centralized systems for energy conversion, DOE emphasizes several options. One area of emphasis is advanced coal and natural gas-fueled power technologies. The aim of this effort is to achieve high efficiency and low emissions, and eventually to integrate these technologies into "Vision 21" plants that will achieve even higher efficiency, provide feedstock and product flexibility, reduce emissions, and lower cost. There is also growing interest in multi-product facilities in which the otherwise wasted heat created by generating electricity is used for industrial applications. Other efforts are focusing on helping to ensure that nuclear plants can deliver affordable supplies beyond their initial 40-year license period. In addition, new reactor designs are being developed that offer improved economics, reduced waste generation, increased safety, and resistance to proliferation.

R&D on distributed and hybrid systems, which includes renewable, fuel cell, and turbine technologies, continues to expand in recognition of the potential environmental benefits and the advantages of increasing distributed generating capacity.

Particular emphasis is placed on technologies that can have a major, long-term impact on greenhouse gas reduction, as well as other benefits, in both domestic and international applications. These technologies include wind, photovoltaics, and biopower renewable systems, and carbon capture/sequestration. Also included are systems to ensure a robust, reliable electricity and natural gas infrastructure, which is needed to serve emerging, competitive, regional and interregional markets.

The Objective's Measures and Strategies

DOE has established the following performance measures. These measures provide the basis by which the Department will know that it has achieved the objective, or is making progress toward it. These measures will be translated into annual targets for performance plans and budgets for the Department. The following strategies describe the way in which the Department will work toward achieving this

objective. These activities will be translated into annual budgets and performance plans for the Department.

Electricity Policy

Measures:

- By 2003, enhance modeling capabilities in the areas of electricity transmission, reliability, and market design so that models can better estimate cost, energy, and environmental impacts, and be used to develop and support policies that provide reliable, clean, and affordable electricity to customers.

Strategy:

- Provide policy, legislative and technology options to encourage the operation of large-scale, interregional, real-time, competitive electricity markets that encompass both centralized and distributed generation sources, while maintaining system reliability and improving environmental performance.

Large, High Efficiency, Advanced Power Systems

Measures:

- By 2005, identify credible candidate designs for fourth generation nuclear power plants that are capable of being deployed in the 2020 time frame.

- By 2008, develop and deploy key enabling power technologies in initial markets, including advanced fuel cells and turbines, and gas separation membranes. By 2015, integrate these technologies through progressive enhancements into a new "Vision 21" generation of fossil fuel based systems:

Vision 21 Energy Plant: The Vision 21 plant depicted here is extremely compact and efficient, with near-zero emissions. Fuels include municipal waste and coal.

  - For use with multiple feedstocks.
  - To achieve near-zero emissions of traditional pollutants.
  - To nearly double the average efficiency of today's operating plants.
  - To be compatible with carbon sequestration systems available in the same time frame.

- By 2015, demonstrate a suite of low-cost and environmentally-safe capture/ sequestration technologies capable of offsetting all projected increases in U.S. greenhouse gas emissions.

Strategies:

- Enhance the economics and environmental performance of electricity generation by expanding the use of multi-product facilities that can also produce heat, clean fuels, and/ or chemical products.

- Pursue evolutionary improvements in existing CO_2 capture systems and explore

revolutionary new greenhouse gas capture and sequestration concepts with a view toward significant cost reductions.

- Develop advanced fossil- and nuclear-based power generation systems that can meet future environmental goals at reasonable cost.

Preserving DOE's Infrastructure

DOE's R&D for large power systems is supported by a variety of major facilities. A considerable infrastructure of DOE owned and operated reactors, accelerators, and hot cells is dedicated to expanding our knowledge of nuclear science and technology. These nuclear facilities are shared across the business lines of National Nuclear Security, Science, Energy Resources, and Environmental Quality. An example of a non-nuclear facility is the Wilsonville Power System Development Facility, which is the most advanced facility in the world for testing future fossil-fueled power technologies. Ensuring the viability of DOE's R&D infrastructure is vital to meeting its goals and objectives.

Renewable, Distributed, and Hybrid Energy Systems

Measures:

- Relative to a 1996 level of 6.5 gigawatts, provide technologies to double renewable energy (non-hydroelectric) generating capacity by 2004, and triple it by 2010. This goal includes (the following do not account for interactions among or between renewable energy supply options):
  - Wind: increase total domestic wind-electric generating capacity from 2.5 GW in 1999 to 10 GW by 2010.
  - Solar: increase total domestic sales of solar-electric (photovoltaic) capacity from 0.4 GW in 1996 to 1 GW by 2004, and to 30 GW by 2020.
  - Geothermal: from the base year of 1999, double the number of States with geothermal-electric facilities from 4 to 8 by 2006; increase from 2.5 to 7 million the number of U.S. homes utilizing geothermal energy by 2010; provide 6 GW of electric generating capacity by 2010 compared with 2.8 GW in 1999; increase the fraction of the electricity used by western states that derives from geothermal resources from 1 percent in 1999 to 10 percent in 2020.
- By 2004, make available for stationary, military, and auxiliary power markets a 5-kilowatt, solid-state fuel cell that has both hybrid and distributed power system applications.
- By 2005 provide technologies that support an increase in the Nation's distributed power to 8 percent of the new electricity capacity, and 20 percent by the end of 2010.
- By 2010, double (from the 1999 level) the installed capacity of combined heat and power systems in the United States to make use of thermal energy otherwise rejected in the generation of electric power.
- By 2010, triple (from the 1999 level) domestic use of bio-based products and bio-energy.

Strategies:

- Improve the performance and expand the use of non-hydroelectric renewable energy generating capacity in the United States.
- Develop technologies to increase the amount of the Nation's distributed power (i.e., electric generating systems connected to the distribution portion of the grid).

Technology Improvements of Operating Plants

Measures:

- Between 2003 and 2008, provide technologies to improve the environmental performance of existing coal-fired power plants and reduce environmental compliance costs by 25-75 percent, compared to existing technologies and strategies.
- By 2010, develop and deploy technologies that will improve the availability of operating nuclear power plants from 75 percent to 85 percent.
- Maintain the current level of national hydropower capability and economic competitiveness.

Strategies:

- Develop technology to improve the performance of older fossil and nuclear power plants, permitting continued operation in an increasingly competitive and environmentally-constrained industry.
- Develop hydroelectric power technologies that are more "fish friendly."

Enhanced Energy System Reliability

Measure:

- For the entire period of this plan, each Power Marketing Administration will receive "pass" as its monthly control compliance rating based on the North American Electric Reliability Council (NERC) performance standards.

Strategy:

- Through the Power Marketing Administrations, market and reliably deliver Federal hydroelectric power with preference given to public bodies and cooperatives.

Boosting Efficiency and Enhancing Process Economics Through Multi-Product Strategies

Historically, the vast majority of domestic electricity generation has been from facilities that produce only electricity and operate at about 30 percent efficiency due to generation, transmission, and distribution losses. Most of these losses are in the form of heat lost during generation. New and emerging technologies, such as advanced turbines, fuel cells, gasifiers, and materials that can act as molecular sieves, are opening up new possibilities. Captured waste heat can be used for buildings or industrial processes. Clean fuels and chemicals can be produced in addition to electricity. Multi-product plants based on these technologies could also be designed with flexibility to use a variety of feedstocks such as coal, natural gas, biomass, and waste fuels.

OBJECTIVE ER3

Increase the efficiency and productivity of energy use, while limiting environmental impacts.

Introduction

In order to meet this objective, DOE develops technology that makes possible cleaner and more efficient vehicles, more energy efficient buildings, and cleaner and more productive industries. To enable commercial production of cleaner and more efficient vehicles, R&D efforts are focused on advanced engines, batteries, and fuels cells to dramatically improve the efficiency of passenger vehicles and light and heavy trucks. Emphasis is also placed on achieving effective, affordable emissions-control technologies for diesel engines. R&D to increase the energy efficiency of buildings focuses primarily on heating, cooling, air conditioning; building material and envelope; building design and operations; and lighting and appliances. Carefully considered performance standards for buildings and appliances reduce overall energy use and improve the quality of building energy services. One of many related efforts is the Federal Energy Management Program within DOE, which is working to reduce the cost of energy at Federal facilities by improving energy and water efficiency, promoting use of renewable energy, and managing utility costs. Another example is the DOE Weatherization Program, which is aimed at improving the energy efficiency of homes for low-income families. (More than 4.7 million homes have been weatherized since 1977, saving $1.80 in energy costs for every dollar invested.) DOE's industry R&D agenda is driven by technology road-mapping activities carried out by the private sector. The aim is to develop and deploy technologies and methods that can significantly improve the efficiency of the Nation's most energy intensive industries and reduce environmental emissions. There are nine "Industries of the Future" in the Department's industry R&D portfolio—the latest additions being mining and agriculture. Included is a "Bio-based Products and Bio-energy Initiative" that is adding emphasis to the Agriculture and Forest Products programs.

The Objective's Measures and Strategies

DOE has established the following performance measures. These measures provide the basis by which the Department will know that it has achieved the objective, or is making progress toward it. These measures will be translated into annual targets for performance plans and budgets for the Department. The following strategies describe the way in which the Department will work toward achieving this objective. These activities will be translated into annual budgets and performance plans for the Department.

Clean and Efficient Vehicles

Measures:

- By 2003, develop advanced clean diesel engine technologies that enable commercial production of pickup trucks, vans, and sport utility vehicles (SUVs) capable of achieving at least a 35 percent fuel efficiency improvement relative to gasoline-fueled trucks.

- By 2004, develop advanced diesel engine and vehicle systems technologies for Class 7 and 8 trucks that allow fuel flexibility, reduced emissions, and reduced parasitic losses (aerodynamic drag, rolling resistance, and drive line losses), thereby increasing the average fuel economy of new, long-haul heavy trucks to 10 miles per gallon (mpg) from the approximately 7 mpg of the late 1990s.

- By 2004, develop advanced technologies to enable production-capable prototype automobiles with approximately three times the fuel economy of conventional automobiles (1993 base year) and achieve the goal of the Partnership for a New Generation of Vehicles.

Strategy:

- Develop and deploy advanced vehicles, fuels, and systems that will significantly increase gas mileage and reduce environmental emissions without compromising safety, comfort, and cost.

Efficient and Affordable Buildings

Measures:

- Reduce annual energy consumption of buildings by 2 Quads (quadrillion BTUs), and save consumers a cumulative $65 billion by 2010.

- Reduce energy consumption in Federal facilities by 35 percent by 2010 relative to the 1985 consumption level, and reduce carbon (equivalent) emissions by about 100 million metric tons.

Strategy:

- Develop products and strategies to increase the efficiency of new and existing residential and commercial buildings.

Clean and Productive Industries

Measures:

- By 2010, reduce industry energy consumption per dollar of output (i.e., energy intensity) to 25 percent below its 1990 level, and reduce cumulative industry energy costs by $4.5 billion.

Strategy:

- Develop technologies and methods that can significantly improve the efficiency of the Nation's energy intensive industries and reduce environmental emissions.

OBJECTIVE ER4

Inform public policy makers, energy industries, and the general public by providing reliable energy information and analysis.

Introduction

By providing information on energy supply, consumption, prices, and the use of alternative technologies, DOE facilitates informed policymaking, technology choices, and efficient energy markets. Much of this information, including development of energy supply and consumption data, and national and international energy projections, is carried out by the Energy Information Administration, an independent statistical and analytical agency within the Department. Program offices at DOE also publish information on potential technical and economic performance of new technologies and approaches.

The Objective's Measures

DOE has established the following performance measures. These measures provide the basis by which the Department will know that it has achieved the objective, or is making progress toward it. These measures will be translated into annual targets for the Annual Performance Plans and published with annual budgets. The following strategies describe the way in which the Department will work toward achieving this objective. These measures will be translated into annual targets for performance plans and budgets for the Department.

- Publish each year a domestic and international *Annual Energy Outlook* that forecasts future energy supply and consumption through the year 2020.
- Maintain and improve web-based networks for the Energy Resources organizations to ensure wide distribution of information about Energy Resources programs, such that the average number of monthly users of Energy Resources Web Sites will grow at least 20 percent per year through 2005 (from a baseline of about 70,000 per month in 1997).
- Periodically provide policy makers with analysis of legislative, regulatory, and other policy issues likely to affect the security, reliability, affordability, environmental impacts, and diversity of the Nation's energy sector.
- Periodically prepare National energy policy plans and energy policy statements for public dissemination.

The Objective's Strategies

The following strategies describe how the Department will work toward achieving this objective. These activities will be translated into annual budgets and performance plans for the Department.

- Provide forecasts for energy supply and consumption through the year 2020.
- Make information more easily accessible to the general public by designing and issuing on-line products for electronic dissemination.

- Undertake information and education programs to familiarize the general public with DOE energy technologies and their applications, availability, and benefits (e.g., environment, health, economics, and reliability).

- Maintain expertise and analytical tools to enable analysis of energy policy issues, and actively participate in the policy making processes with other Federal and State agencies and with Congress.

OBJECTIVE ER5

Cooperate globally on international energy issues.

Introduction

International cooperation is the key to strengthening world energy markets, speeding technology development and deployment, and addressing global environmental challenges. Oil markets, and increasingly other energy markets, are truly global. Ensuring market competition and emergency preparedness requires international cooperation, as well as domestic action. Technology development and deployment efforts are also global in nature, involving billions of dollars of trade, hundreds of national and multinational companies, and a similar number of government agencies, both domestic and foreign. The Department actively supports international cooperation in technology development, emergency preparedness, and policy coordination through the International Energy Agency and numerous other multi-lateral and bilateral efforts.

The Objective's Measures

DOE has established the following performance measures. These measures provide the basis by which the Department will know that it has achieved the objective, or is making progress toward it. These measures will be translated into annual targets for performance plans and budgets for the Department.

- Achieve $3 billion in annual export sales of energy-efficiency technologies by 2010.
- Achieve $5 billion in annual export sales of renewable energy systems by 2010.
- For U.S. companies in energy efficiency, renewables, oil and gas recovery, and clean coal technology, remove barriers to markets in China, Indonesia, the Philippines, Brazil, India, South Africa, the Newly Independent States, and other developing economies.
- Implement an international agreement with Brazil to assist that country in instituting economic reforms, attracting foreign capital and technologies, and promoting clean coal technologies.
- Through government-to-government efforts, provide information that affects the legal/ regulatory framework of at least one developing country each year in a way that encourages U.S. private sector energy investment.

The Objective's Strategies

The following strategies describe the way in which the Department will work toward achieving this objective. These activities will be translated into annual budgets and performance plans for the Department.

- Enhance energy security by increasing the capacity and diversity of international oil and gas producers.
- Promote open energy markets.
- Promote deployment of clean and efficient energy systems.

- Assist the Administration in obtaining commitments from key developing countries to reduce greenhouse gas emissions.

Linkage to Budget Structure

The Energy Resources general goal is supported by five objectives. Each objective is being pursued through long-term strategies. DOE's Budget Decision Units fund work in pursuit of long-term strategies. The annual performance measures are discussed with the Decision Units in the Annual Performance Plan, which is submitted with the budget for each fiscal year. The following chart shows the relationship between Decision Units and objectives.